

Software Life Cycle Management Guidelines

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Introduction

It is the policy of the Information Services Board (ISB) that each agency must adhere to a structured life cycle approach in the planning, justification, implementation, and assessment of technology investments. The primary objective of this approach is to create a uniform and disciplined process for producing high-quality systems that satisfy functional requirements at the lowest feasible cost, within schedule and budget.

Statutory Authority

The provisions of RCW 43.105.041 detail the powers and duties of the ISB, including the authority to develop statewide or interagency information services and technical policies, standards and procedures.

Scope

These guidelines describe the software life cycle management concept, the need for change to the current software development model, current initiatives, benefits, applicability to agencies, and critical success factors.

These guidelines set forth a description of essential steps to be taken to implement a life cycle process.

Each agency should design and tailor a program that is suitable to support its particular information technology (IT) initiatives and ongoing activities. A primary feature of this life cycle management approach is its functional flexibility. Agencies need to implement only the sub-processes suitable to their needs.

Exemptions

None.

Guidelines

At a minimum, agencies will develop a software life cycle process that addresses the following:

- Project definition
- Requirements analysis
- Risk management plan
- Quality assurance plan
- General design
- Feasibility study
- System requirements
- Software requirements
- Detailed system design
- Construction
- System implementation and testing
- Training
- System operational support
- System maintenance support

Need for Changing the Current Software Development Process

The task of developing and implementing software to support complex business processes on time and within budget has been less than satisfactory for many companies and government agencies implementing major information systems. For many organizations, the likelihood of failure is unacceptably high. This suggests that perhaps the traditional approaches and assumptions used in the software development process are inherently flawed. According to recent research, "Companies and governments in the United States spend more than \$250 billion each year on information technology application development of approximately 175,000 projects. Over 31% (54,250) of these projects will be cancelled before they ever get completed in large companies, and only 9% of projects will come in on time and on budget. In 1995

American companies and governments spent \$81 billion for cancelled software projects.” (California Department of Information Technology, Annual Report , 1996, page 16.)

Projects involved in designing and implementing software generally rely on development methodologies, such as computer-aided software engineering (CASE) tools. This approach, however, has resulted in marginal success, as attested to by the large number of failures described above. While tools and people are essential to software projects, experts now agree there is the need for well-defined, structured, and disciplined management processes that ensure results: a comprehensive management process that provides the necessary structure to support the design, implementation, and maintenance of software throughout its life cycle.

The software process improvement (SPI) and life cycle management concepts and methodologies discussed on the following pages describe an appropriate process management system. An important consideration is tailoring the program to fit the agency’s requirements. Emphasis should be placed on having an effective system that does the job properly and adds value to the process. Features or functions that do not add value should be discarded.

SPI Initiatives

In the past few years a number of private and public initiatives have focused on developing new and better methods for managing and implementing the software development process. The Department of Defense (DoD), believing that improved software process tools would help avoid costly project overruns, funded the Carnegie-Mellon University Software Engineering Institute (SEI) to design a method for assessing the capability of software contractors. This effort resulted in the Capability Maturity Model (CMM) that is used by DoD and has become a standard for assessing an organization’s capability to manage software development.

The Benefits of SPI

Persuasive evidence shows a strong correlation between improved software process management and project performance. For example, one study of the impact of software improvement programs summarized the results as follows:

- \$490 to \$2,004 invested per software engineer, per year
- 9 to 67 percent annual increase in productivity
- 15 to 23 percent annual reduction in cycle time
- 10 to 94 percent annual reduction in field error reports
- Return on investment ranging from 4:1 to 8.8:1

Other potential benefits include:

- Reduction of IT project risk areas, particularly those associated with internal risk, such as lack of executive management and user support, unavailability of resources, and inadequate planning
- Significant reduction of project oversight costs for medium and high risk projects
Increased confidence from the Legislature, Office of Financial Management, ISB, and DIS, resulting in greater independence for the agency, reduced reporting requirements, and willingness to support additional projects.

Relationship to IT Portfolio

In addition to making good business sense, implementing an appropriate software life cycle program is a state policy requirement. An appropriate life cycle program is an essential component of the IT Portfolio program. As described in the IT Portfolio Management Standards, all agency projects should undergo a risk assessment that determines an overall risk category. The risk assessment determines which projects must be included in the agency's IT Portfolio.

Standards

In recent years, a number of IT standards have been developed and ratified by the International Standards Organization (ISO) and the International Electrotechnical Commission (IEC). Development of standards is performed by committees, sub-committees and working groups composed of representatives from industry, governmental national standards organizations, and non-government organizations. It is the practice of U.S. standards committees, such as the American National Standards Institute and the Institute for Electrical and Electronic Engineers, to assign representatives to work on these committees and align them to U.S. Standards when possible.

Examples of relevant standards that agencies should consider include the ISO 9000 (Quality Management for Manufacturing), ISO/IEC 12207 (Software Life Cycle Processes), ISO 15504 (Draft: Software Process Assessment), and the CMM developed by the Software Engineering Institute (SEI).

An important point regarding the use of standards (technical and management) is that compliance is voluntary. Establishing a program does not imply independent certification is required. For example, this guideline proposes agencies perform their own assessments and record the results accordingly in the IT Portfolio. In addition, organizations can determine which elements of a standard apply and implement them at their own pace. However, once an organization has defined the elements it plans to implement, it must implement the program in a manner that is consistent with the standard for those elements.

Applicability

Because agencies do not have identical operating conditions, IT operations, or project development activities, each agency will have to tailor its programs to its unique needs

and circumstances. Large agencies should be able to determine the scope of their life cycle program requirements in a relatively straightforward manner. Small agencies, however, especially agencies with few or no internal IT resources and/or no major business systems, may not require such a program. Agencies may consult DIS for assistance in determining their needs.

Critical Success Factors

Successful software development requires a combination of leadership, stakeholder support, and long-term executive commitment. Critical success factors essential for achieving successful life cycle program implementation include:

- Business vision
- Stakeholder consensus
- Management support
- Identification and assignment of dedicated resources
- Management plan
- Prioritized action items
- Infrastructure support
- Monitoring results
- Feedback mechanism

Preparing the Ground Work

Instituting organizational change requires aggressive executive leadership and commitment. Employees should understand that what they are about to go through is a sincere effort to make meaningful improvements that benefit their agency. Over the past 30 years, businesses and governmental agencies have made numerous attempts to improve organizational capabilities through quality improvement programs, such as Zero Defects, Quality Circles, and most recently Total Quality Management. The path toward meaningful quality improvement has been long and very expensive. In many cases, well-intentioned attempts have failed to improve quality and in the process have succeeded in making employees feel cynical about subsequent attempts. It is important to recognize that poorly planned attempts, without full executive support, are more damaging than not doing anything at all. Before embarking on this effort, senior managers must lay the groundwork for achieving success, which includes the following:

Be Realistic – Recognize that change does not come easily and frame the design and implementation of the program into manageable and achievable steps.

Become Knowledgeable – Leadership must be educated on the concepts of SPI before they can effectively direct staff. There are commercial sources that provide executive-level education. These classes usually last from one-to-three days. Training should be tailored in the context of state agencies and their IT operating environments.

It is recommended that training be held off-site to minimize the opportunity for distraction and interruptions while inspiring team building.

Designate an Executive Sponsor – Support and direction must come from the highest level within the organization. Agency directors or deputy directors should assume executive leadership responsibility to ensure the program is properly implemented. While a project manager is responsible for the day-to-day activities, the project will require continuous executive leadership and personal attention to succeed.

Following are summary descriptions of the principal activities required to implement process change. The steps outlined below generally represent features commonly found in SPI.

Preparing for SPI

Successful implementation of a SPI program involves the following stages or their equivalent:

Stage 1: Launching – Introduce key managers to the concepts. Education and team-building activities are required to achieve the desired level of understanding, team cohesiveness, and commitment to success.

Stage 2: Implementing – Develop and adopt a strategy for SPI. Conduct an assessment and implement an action plan. A project team should be assigned with sufficient resources to perform these duties.

Stage 3: Institutionalizing – SPI is continuous and integral to the agency's culture. (This is probably the most difficult objective to achieve).

Stage 4: Measuring – Establish a means to measure benefits and performance.

Stage 5: Improving – A change management process ensuring business requirements, policy, procedures, and the IT system are properly aligned and effective.

The following discusses these stages in greater detail:

Stage 1: Launching the SPI Program.

This stage focuses on developing a vision and strategy, realigning resources, motivating the team, and developing the implementation plan. Each of these elements is briefly described below:

Vision concerns the agency's future business direction and requirements. The objective is to ensure alignment between the SPI program and the business vision. The IT Portfolio requires this step be reassessed annually.

Strategy involves developing various strategies (primary and alternate) to achieve the vision. Vision is a long-term, futuristic view; strategies deal with major initiatives (mid- to long-range) that will achieve the vision. Strategy deals with what is real and achievable. The key is to ensure an alignment between the vision and strategy supporting the business goals and the SPI program. This alignment and relationship should be reflected in the agency IT Portfolio.

Alignment involves adjusting the SPI program to support the organization's business objectives. Business needs define the substance of the SPI program. Therefore, the program should be designed to support the business requirements in context of business needs.

Motivation is concerned with securing senior management support for the program. Unless senior executives are committed personally to achieving success, the program is likely to fail. Motivation and enthusiasm naturally cascade down through the organization. Therefore, the informal leadership usually knows if what they are experiencing is real or not. Leaders are responsible for motivating not only the staff but other stakeholders as well. Stakeholders include anyone who has an interest in the program's success.

Implementation involves detailed planning for the subsequent implementation. This plan should ensure that SPI is in alignment with the organization's current business goals, structure, project-team capabilities, tools, and IT resources. The plan should address the following:

- Agency issues
- Work unit issues (i.e., branches, sections, work centers, etc.)
- Project team issues
- Individual employee issues

The above description is a high-level view of a detailed and comprehensive process. This brief outline is intended to give the reader some idea of what the process involves. The above steps are generic and do not necessarily relate to specific models or products. There are various methodologies available that address specifics and other necessary elements that launch SPI programs.

Stage 2: Implementing

Implementing process improvements is far too complex to be addressed in this guideline. Before embarking, the process improvement teams will require special training and possible consulting support in the early stages of the program. It is important to note that process improvement is a continuous activity.

Essential components of the implementation stage are introducing and managing change. The ultimate goal is to change individual behavior into accepting a new

process-oriented culture. The following key participants are required to accomplish this change:

- **Project manager** – Full-time resource responsible for managing the SPI action plan and coordinating activities. This individual must also have excellent interpersonal and communication skills.
- **Project Improvement Teams (PIT)** – Technically qualified persons who will lead the implementation of the improvement actions. These team members also should have excellent interpersonal and communication skills.
- **Executive Steering Committee** – Provides overall guidance and direction concerning policy and organizational issues. These committees typically have five to seven members and include senior managers from within the organization. The SPI project manager usually attends these meetings.
- **Budget** – Appropriately funded to support a multi-year program. The initial SPI cycle likely will take 12 to 24 months to implement. Subsequent cycles usually take 6 to 18 months. However, the level of effort for the second and subsequent cycles should diminish considerably, assuming SPI is successful.

The major elements of the implementation stage include the following:

Conduct a Capability Assessment – The objective is to understand the current process. The results provide the baseline for developing improvement action plans. Care should be taken to ensure that employees do not perceive assessments as attempts to find fault within the organization. Management should emphasize the positive effects of the program by identifying and solving root problems. An assessment is a catalyst for change; outputs from the assessment constitute an action plan.

Prioritize Areas for Improvement – The assessment identifies opportunities for improvement, which are then prioritized against agency business requirements. The action plan reflects the sequence in which improvements will be made. Dependent and independent issues should be separated. In some cases, issues might have a low priority for being resolved, but they might be an important step that must be completed before more important issues can be resolved.

Prepare and Execute SPI Action Plans – Generally these opportunities for improvement fall into logical groupings, such as redesigning or improving current processes, designing new processes, or improving or redesigning the process improvement environment. Teams can then be assigned to develop and execute the action plans concerning one of these logical categories.

Managing Change – As previously stated, the ultimate objective is to change behavior. The objective is to convince managers and employees that change will benefit them as much as it will benefit the organization. This project will ultimately result in a process-oriented culture and infrastructure requiring new or revised policies, procedures,

training, and job assignments. In addition new measures for assessing performance will be required.

Change management is perhaps the most critical step in the implementation process. Because of the complexity of change, it is absolutely essential that every effort be made to provide the necessary training and tools to support the process. However, as previously stated, the first and foremost requirement is executive commitment and perseverance. Without this commitment, meaningful change is unlikely to occur.

Stage 3: Institutionalizing Change

Institutionalizing change is defined as establishing an environment or condition where improved policies, procedures, and practices continue as a matter of business even if the original sponsors leave the organization. Achieving this goal is the ultimate compliment to effective management.

Once the first cycle of process changes has been implemented, there must be an executive level assessment of the results, and an action plan must be developed for the next round of improvements. This continuous process follows the classic quality improvement process. Regarding SPI, the SEI has developed an implementation approach for software improvement. This approach describes the necessary phases, activities, and resources required for a successful process improvement program. This model is referred to as IDEAL.

The acronym relates to the initials of the five stages of the SPI cycle, which stand for the following:

- I = Initiating
- D = Diagnosing
- E = Establishing
- A = Acting (plan, do, check, act)
- L = Learning

Similar tools are also available commercially that can be used to support this process. As previously discussed, agencies can select the appropriate tools and methods for their organizational needs. If agencies work collectively to identify a standard set of primary development and implementation tools that could be used by a number of agencies, meaningful benefits could include:

- A pool of knowledgeable employees who become intimately familiar with the tools and methodologies being developed. (This pool could become a resource to other agencies that do not have the staff to perform this work.)
- A standard approach that would provide a useful tool for agencies that subsequently implements the program.
- Common experience that enables user groups to discuss similar problems, share new ideas, and learn from others

- Cost savings on products and tools through site license purchase options

Evaluating Process Performance

Stage 4: Measuring

Measuring performance is an essential step in the life cycle of process improvement. Unless there is some means to measure performance (the output of the program), managers will not have the ability to determine whether or not the original investment provided benefit or whether additional investment is warranted. The program should add value to the business process or otherwise be cancelled. However, unless a performance measuring system is in place, a program cannot justify continued funding.

Agency Reporting and Performance Measurement

The agency's executive sponsors establish the SPI progress-reporting data elements and report frequency requirements. Care must be taken to ensure that what is being measured and reported truly reflects the project status. The following should be considered when establishing report contents:

- Report information that provides evidence of the accomplishment of the project objective
- Measurements should focus on project performance and project results
- Reporting measures and criteria should be established prior to initiating the project

There are a number of specialized commercial products designed for setting up a project performance measurement system.

Reporting to the ISB

Agencies that implement life cycle management programs should periodically present the status of their implementation efforts to the ISB. The objective is to ensure that the ISB is aware of the issues and resource requirements needed to implement the program and to make informed decisions should the policy need to be adjusted. The information reported to the ISB should be consistent with what is reported to the agency director by the project manager.

Stage 5: Improving

Software Life Cycle Management

Software life cycle management, like other quality improvement programs (ISO 9000 for manufacturing and ISO 14000 for environmental management systems) is a journey that never ends. Organizational change is a constant. New technologies, new requirements, new legislation, new team members, new leadership are just some of the impacts an agency must manage. A system designed to support business processes must be regularly enhanced to support user requirements. If not, system performance and capabilities will erode, resulting in increased operational costs, degraded customer service, and possible loss of revenue. The need to continuously improve software

processes is the same. Consequently, the process changes brought about in the initial SPI program will require periodic reviews and improvement.

Continuous improvement requires a change management program designed to ensure balance among policies, procedures, tools, training, skills, and business requirements. Without this balance, a breakdown in the process will eventually happen, increasing costs for software development, extension of deliverable schedules, and increased customer dissatisfaction.

Developing a Change Management Program

Change management is necessary whenever an organization is using IT to support its business processes. It is intended to ensure there is functional and technical balance between the organization's information systems and business processes, policies, procedures, and employee skills and training.

Agencies that currently have a change management program supporting their information systems need only to expand it to cover the agency SPI program. Agencies that do not have a change management program will need to establish one concurrent with executing the SPI process.

Change management involves the "plan, do, check, act" cycle associated with quality improvement. This is a continuous process. Depending upon the size of the organization, available resources, and performance indicators, subsequent process improvement cycles may take six to eighteen months to accomplish. This repetitive process is essentially a repetition of the activities conducted in the initial SPI cycle. A description of the key steps of this process are described below:

- **Recognition of Need for Improvement** – Required when performance measures and other analysis indicate problems or opportunities for change. This is usually the first formal step in the SPI cycle. (Note: If the initial SPI cycle action plan implementation was successful, this and subsequent cycles will be less intensive and time consuming.)
- **Senior Management Commitment** – Without management commitment, the program will not succeed.
- **Assessment Preparation** – Following the initial SPI cycle, performance results must be analyzed. The PIT will develop new assessment strategies and work plans similar to those that were prepared for the first assessment cycle.
- **Assessment** – The PIT perform the assessment as previously described.
- **Recommendations and Action Plan Formulation** – The assessment results and recommendations must be presented to executive management. The outcome is a thoughtful action plan.

- **Action Plan Implementation** – The final step requires implementing the improvements approved by executive management.

Essential to this process are effective feedback mechanisms. Agency management must ensure it is receiving input from key stakeholders. Stakeholders include process users (agency personnel and customers), project managers, division, branch, section, and unit managers.

Maintenance

Technological advances and changes in the business requirements of agencies will necessitate periodic revisions to policies, standards, and guidelines. The Department of Information Services is responsible for routine maintenance of these to keep them current. Major policy changes will require the approval of the ISB.